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| EXAMINER | |
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| KIM, JAY C | |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/573,239 | MARTSINOVSKY ET AL. | |
| | Examiner | Art Unit | |
| | JAY C. KIM | 2815 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *23 June 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-8,10-19 and 21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-8,10-19 and 21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *23 June 2008* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

This Office Action is in response to the Amendment filed June 23, 2008.

### *Drawings*

1. New corrected drawings in compliance with 37 CFR 1.121(d) are required in this application because, in the drawings filed June 23, 2008, in Fig. 1b numerals 104 and 110 are switched compared to the original Fig. 1b, and in Fig. 1c numeral 104 should be replaced with another numeral, because numeral 104 refers to a collector. Applicant is advised to employ the services of a competent patent draftsperson outside the Office, as the U.S. Patent and Trademark Office no longer prepares new drawings. The corrected drawings are required in reply to the Office action to avoid abandonment of the application. The requirement for corrected drawings will not be held in abeyance.

### *Specification*

2. The disclosure is objected to because of the following informalities: on lines 14-15 of the amended paragraph [0018], "a" should be inserted before "metal emitter", and numeral 104 should be replaced with another numeral, because numeral 104 refers to a collector. Appropriate correction is required.

### *Claim Objections*

3. Claims 1 and 12 are objected to because of the following informalities:

On line 1 of claim 1, "the collector" should be replaced with "a collector".

On line 1 of claim 12, “the” before “tunneling” should be removed.

Appropriate correction is required.

### *Claim Rejections - 35 USC § 112*

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 12, 14 and 16-19 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Regarding claim 12, it is not clear what "said distance” “being evacuated or filled” refers to, because a distance cannot be evacuated and filled. In the below prior art rejections, it is interpreted that a gap between the emitter and the collector is evacuated or filled with an inert gas under low pressure. Claims 14 and 16-19 depend on claim 12, and therefore claims 14 and 16-19 are also indefinite.

6. Claim 12 recites the limitation "said emitter surface" in a method for promoting tunneling of electrons. There is insufficient antecedent basis for this limitation in the claim. Claims 14 and 16-19 depend on claim 12, and therefore claims 14 and 16-19 are also indefinite.

***Claim Rejections - 35 USC § 102***

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1-3, 5, 10-14, 16 and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Cox (US 6,064,137).

Regarding claims 1 and 5, Cox discloses a tunnel diode (Figs. 1g and 5) in which a collector (composite layer of 8 and 6) (col. 8, lines 27-28 and 30-31) comprises a band gap material (6), the band gap material being a crystal material having filled zero temperature valence band and empty conductive band, and the band gap material is a diamond material, wherein the collector (composite layer of 8 and 6) is separated from an emitter (composite layer of 4 and 6) (col. 8, lines 24-25) by a gap (gap between layers 6 in Fig. 1g or gap between layers 30 in Fig. 5), the gap being evacuated (col. 8, lines 54-55).

Regarding claim 2, Cox further discloses that the emitter (composite layer of 4 and 6) comprises a metal (4) (col. 8, lines 24-25).

Regarding claim 1 (alternate interpretation), Cox discloses a tunnel diode (Figs. 1g and 5) in which a collector (composite layer of 8 and 6) (col. 8, lines 27-28 and 30-31) comprises a band gap material (6), the band gap material being a crystal material having filled zero temperature valence band and empty conductive band, wherein the

collector (composite layer of 8 and 6) is separated from an emitter (4) (col. 8, lines 24-25) by a gap (gap between layers 6 in Fig. 1g or gap between layers 30 in Fig. 5), the gap being evacuated (col. 8, lines 54-55).

Regarding claims 2 and 21 (using alternate interpretation), Cox further discloses that the emitter (4) comprises a metal (4) (col. 8, lines 24-25) in which the emitter (4) has a layer of band gap material (6) deposited thereupon.

Regarding claim 3, Cox further discloses for the tunnel diode of claim 1 that the collector (composite layer of 8 and 6) comprises a metal (8) (col. 10, line 44) having a layer of band gap material (6) deposited thereupon.

Regarding claim 10, Cox discloses a vacuum diode heat pump (Fig. 5) comprising the tunnel diode of claim 1 (col. 11, lines 24-29).

Regarding claim 11, Cox discloses a heat to electricity converter (Fig. 5) comprising the tunnel diode of claim 1 (col. 7, lines 54-55).

Regarding claims 12 and 16, Cox discloses a method for promoting tunneling of electrons having an energy level higher than the Fermi level of an emitter (composite layer of 4 and 6 in Figs. 1g and 5) (col. 8, lines 24-25 and 30-31), from an emitter surface, comprising the step of positioning a collector (composite layer of 8 and 6) (col. 8, lines 27-28) comprising a band gap material (6), which is a diamond material, at a distance within the tunneling range of the electrons, which is inherent for the tunneling gap diode (Figs. 1g and 5) to operate, the band gap material (6) being a crystal material having filled zero temperature valence band and empty conductive band and a gap

between the emitter (composite layer of 4 and 6) and the collector (composite layer of 8 and 6) being evacuated (col. 8, lines 54-55).

Regarding claim 13, Cox discloses a method for suppressing back tunneling of electrons in a tunnel diode (Figs. 1g and 5) comprising the step of coating a collector (8) (col. 8, lines 27-28) with a layer of a band gap material (6) (col. 8, lines 30-31), the band gap material (6) being a crystal material having filled zero temperature valence band and empty conductive band, and the collector (8) being separated from an emitter (composite layer of 4 and 6) (col. 8, lines 24-25) by a gap (gap between layers 6 in Fig. 1g or gap between layers 30 in Fig. 5), the gap being evacuated (col. 8, lines 54-55).

Regarding claim 14, Cox further discloses for the method of claim 12 that the collector (composite layer of 8 and 6) comprises a layer of band gap material (6) deposited on a metal collector (8) (col. 10, line 44).

9. Claims 1, 3-6 and 10-17 are rejected under 35 U.S.C. 102(b) as being anticipated by Bell (US 4,280,074).

Regarding claims 1, 5 and 6, Bell discloses a tunnel diode (Figs. 2 and 8) in which a collector (Fig. 2 and 36 in Fig. 8) (col. 4, line 54) comprises a band gap material (composite layer of 25-27) (col. 3, lines 56-62), the band gap material (composite layer of 25-27) being a crystal material having filled zero temperature valence band and empty conductive band, and the band gap material (composite layer of 25-27) is a semiconductor such as GaAs (col. 4, lines 60-62), wherein the collector (Fig. 2 and 36

in Fig. 8) is separated from an emitter (35) (col. 4, line 59) by a gap (gap between emitter 35 and collector 36), the gap being evacuated (col. 4, lines 58-59).

Regarding claim 3, Bell further discloses that the collector (Fig. 2 and 36 in Fig. 8) comprises a metal (28 in Fig. 2) having a layer of band gap material (composite layer of 25-27) deposited thereupon.

Regarding claim 4, Bell further discloses that the layer of band gap material (composite layer of 25-27) has a thickness (col. 4, lines 62-63) greater than the mean distance of relaxation of electrons tunneling from the emitter (35), which is ~ 10 nm or more (current Application, line 37 of page 2 - line 1 of page 3).

Regarding claim 10, Bell discloses a vacuum diode heat pump (Fig. 8) comprising the tunnel diode of claim 1, because heat is transferred from the heat source (37) to the heat sink (38) by electron emission from the emitter (35).

Regarding claim 11, Bell discloses a heat to electricity converter (Fig. 8) comprising the tunnel diode of claim 1, because electrons are emitted from the emitter (35) in contact with the heat source (37).

Regarding claims 12, 16 and 17, Bell discloses a method for promoting tunneling of electrons having an energy level higher than the Fermi level of an emitter (35) (col. 4, line 59), from an emitter surface, comprising the step of positioning a collector (Fig. 2 and 36 in Fig. 8) (col. 4, line 54) comprising a band gap material (composite layer of 25-27) (col. 3, lines 56-62) at a distance within the tunneling range of the electrons, which is inherent for the tunnel diode (Figs. 2 and 8) to operate, the band gap material (composite layer of 25-27) being a crystal material having filled zero temperature

valence band and empty conductive band, and the band gap material (composite layer of 25-27) is a semiconductor such as GaAs (col. 4, lines 60-62) and a gap between the emitter (35) and the collector (Fig. 2 and 36 in Fig. 8) being evacuated (col. 4, lines 58-59).

Regarding claim 13, Bell discloses a method for suppressing back tunneling of electrons in a tunnel diode (Figs. 2 and 8) comprising the step of coating a collector (28 in Fig. 2) (col. 3, lines 55-56 and 62) with a layer of a band gap material (composite layer of 25-27) (col. 3, lines 56-62), the band gap material (composite layer of 25-27) being a crystal material having filled zero temperature valence band and empty conductive band, and the collector (28) being separated from an emitter (35) (col. 4, line 59) by a gap (gap between emitter 35 and layer 36 in Fig. 8), the gap being evacuated (col. 4, lines 58-59).

Regarding claim 14, Bell further discloses for the method of claim 12 that the collector (Fig. 2 and 36 in Fig. 8) comprises a layer of band gap material (composite layer of 25-27) deposited on a metal collector (28).

Regarding claim 15, Bell further discloses that the layer of band gap material (composite layer of 25-27) has a thickness (col. 4, lines 62-63) greater than the mean distance of relaxation of electrons tunneling from the emitter (35), which is ~ 10 nm or more (current Application, line 37 of page 2 - line 1 of page 3).

***Claim Rejections - 35 USC § 103***

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. Claims 7, 8, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cox (US 6,064,137) in view of Tavkhelidze et al. (US 6,417,060). The teachings of Cox et al. are discussed above.

Regarding claims 7, 8, 18 and 19, Cox differs from the claimed invention by not showing that the gap is in the range 1-100nm (claim 7), that the gap is in the range 1-10nm (claim 8), that the collector and the emitter are separated by a gap in the range 1-100 nm (claim 18), and that the collector and the emitter are separated by a gap in the range 1-10 nm (claim 19).

Tavkhelidze et al. disclose a tunnel diode (Fig. 2) comprising an emitter (5) (col. 3, line 33) and a collector (1) (col. 3, line 35), wherein the emitter (5) and the collector (1) are separated by a gap in the range 50 nm or less, preferably 5 nm or less (lines 9-12 of ABSTRACT).

Since both Cox and Tavkhelidze et al. teach a tunnel diode, it would have been obvious to the one of ordinary skill in the art at the time the invention was made that the emitter and the collector disclosed by Cox may be separated by a gap in the range disclosed by Tavkhelidze et al., for example, ~ 5 nm, because the gap distance between

the emitter and the collector in the tunnel diode can be varied to control electron tunneling and thus the performance of the tunnel diode.

Further regarding claim 7, 8, 18 and 19, the claims are prima facie obvious without showing that the claimed ranges of the gap achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

12. Claims 7, 8, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bell (US 4,280,074) in view of Tavkhelidze et al. (US 6,417,060). The teachings of Bell et al. are discussed above.

Regarding claims 7, 8, 18 and 19, Bell differs from the claimed invention by not showing that the gap is in the range 1-100nm (claim 7), that the gap is in the range 1-10nm (claim 8), that the collector and the emitter are separated by a gap in the range 1-100 nm (claim 18), and that the collector and the emitter are separated by a gap in the range 1-10 nm (claim 19).

Tavkhelidze et al. disclose a tunnel diode (Fig. 2) comprising an emitter (5) (col. 3, line 33) and a collector (1) (col. 3, line 35), wherein the emitter (5) and the collector (1) are separated by a gap in the range 50 nm or less, preferably 5 nm or less (lines 9-12 of ABSTRACT).

Since both Bell and Tavkhelidze et al. teach a tunnel diode, it would have been obvious to the one of ordinary skill in the art at the time the invention was made that the electrodes disclosed by Bell may be separated by a gap in the range disclosed by Tavkhelidze et al., for example, ~ 5 nm, because the gap distance between the electrodes in the tunnel diode can be varied to control electron tunneling and thus the performance of the tunnel diode.

Further regarding claim 7, 8, 18 and 19, the claims are prima facie obvious without showing that the claimed ranges of the gap achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

***Double Patenting***

13. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

14. Claims 1-8, 10-19 and 21 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-9 and 11-15 of copending Application No. 11/392,182. Although the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-9 and 11-15 of Application No. 11/392,182 include all the recited limitations of claims 1-8, 10-19 and 21 of current Application.

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

***Response to Arguments***

15. Applicants' arguments filed June 23, 2008 have been fully considered but they are not persuasive.

In response to applicants' arguments, the recitation "tunnel diode" has not been given patentable weight because the recitation occurs in the preamble. A preamble is generally not accorded any patentable weight where it merely recites the purpose of a process or the intended use of a structure, and where the body of the claim does not depend on the preamble for completeness but, instead, the process steps or structural limitations are able to stand alone. See *In re Hirao*, 535 F.2d 67, 190 USPQ 15 (CCPA 1976) and *Kropa v. Robie*, 187 F.2d 150, 152, 88 USPQ 478, 481 (CCPA 1951).

Applicants argue that "claims 11-19 of the present invention concern methods to do with electron tunneling", and that "the two references cited in support of a rejection under 35 USC 102(b) are to do with thermionic emission, a process Examiner will readily appreciate is a ballistic emission of electrons into a space between an emitter electrode and a collector electrode". Merriam-Webster dictionary defines "tunneling" as "to pass through a potential barrier", and Applicants do not provide evidence that no electrons are transported to the collector via tunneling. Rather, along the line similar to 35 USC 112 rejection of original claim 13 that Applicants agreed upon, there is always a probability that electrons may tunnel from the emitter to the collector according to quantum mechanics. Further, Applicants do not claim that tunneling is the main mechanism for electron transport. Therefore, Cox and Bell inherently disclose an electron tunneling.

Applicants argue that "none of the teachings of Cox or Bell have any bearing on a quantum mechanical tunneling process, and the methods taught in these two pieces of prior art have no value in providing improved approaches to exploiting electron tunneling". Please see the above response. Cox and Bell disclose the structure Applicants claim, and therefore would provide improvement in electron tunneling.

Applicants argue that "in claims 1, 3, 5, 9-14 and 20 of the present invention, only the collector electrode (anode) comprises a band-gap material". Applicants do not claim specifically that the emitter does not comprise a band-gap material.

Applicants argue that "in claims 1-3, 5, 9-14, 16 and 20 of the present invention, neither the emitter nor the collector are coated with an insulating film". Applicants do not claim specifically whether or not the emitter or the collector is coated with an insulating film.

Applicants argue that "the emitter and collector are separated by a gap, not by spacers". Applicants do not claim specifically that the emitter and the collector are separated by a gap with no other gap between the emitter and the collector. Also, Applicants do not claim specifically that there are no spacers holding the side surfaces of the emitter and the collector.

Applicants argue that "Cox's anode comprises an additional metal base layer in comparison to the collector or anode of the present invention which can function comprising a band gap material alone". Applicants do not claim specifically that the collector consists of only a band gap material.

Applicants argue that "in claims 1, 3-6, 9-17 and 20 of the present invention, the collector electrode does not comprise a cesiated layer, nor does the gap between the electrodes comprise a work function lowering activator, such as a cesium vapor; this latter is made clear by the scope of claims 9 and 20". Applicants do not claim specifically that the collector does not comprise a cesiated layer. Bell discloses that the gap can be in vacuum.

Applicants argue that "Bell's device is a thermionic converter rather than a tunneling diode". Please see the above response. Bell discloses a tunnel diode.

Applicants argue that "nowhere in the specification does Bell disclose an inter-electrode separation; this is as expected, since Bell's invention, as a thermionic converter, is not of a nature to require a specialised electrode separation". Please see the above response. Bell discloses a tunnel diode. Further, Applicants do not provide evidence that the gap between the emitter and the collector disclosed by Bell cannot be optimized.

Applicants argue that "there is therefore no indication in Bell that the collector is positioned within the tunneling range of electrons from an emitter". Along the line similar to 35 USC 112 rejection of original claim 13 that Applicants agreed upon, there is always a probability that electrons may tunnel from the emitter to the collector according to quantum mechanics. Further, Applicants do not provide evidence that the collector is not positioned within the tunneling range of electrons from an emitter.

Applicants argue that "Cox does not teach a tunnel diode", and that "Cox's invention is a thermionic emitter in which 'the exact emission mechanism is not well

understood' (Col. 5, lines 53-54) and electrons travel from emitter to collector electrodes due to a temperature gradient (Col. 7, lines 1-2)". Cox discloses a tunnel diode as discussed above. The recitation that "the exact emission mechanism is not well understood" is regarding the background art, not regarding the Cox's invention. Lack of understanding of exact mechanism does not mean that Cox does not disclose a tunnel diode. Further, Applicants claim a vacuum diode heat pump in claim 10 which would have a similar structure to what Cox discloses.

Applicants argue that "it would not be obvious to combine features of Cox with Tavkhelidze since the two devices function differently and therefore do not necessarily lend themselves to equal electrode separation". Both Cox and Tavkhelidze disclose a tunnel diode which can operate as a vacuum diode heat pump, and the combination of Cox and Tavkhelidze et al. would be obvious to optimize the gap separation.

Applicants argue that "Cox explicitly teaches away from the 5 nm gap suggested by Examiner". Cox discloses that the space between the cathode and anode will typically be very small (col. 9, lines 48-49). Also, the Examiner used a composite layer of 4 and 6 as an emitter and a composite layer of 8 and 6 as a collector, while Cox calls the layer 4 as a cathode and the layer 8 as an anode. In other words, even though the gap between the cathode and the anode disclosed by Cox may be separated by about 500 nm, the vacuum gap between the composite layer of 4 and 6, and the composite layer of 8 and 6 may be about 5 nm.

Applicants argue that "Cox advertises that one of the advantages of his device is the potential for setting the cathode and anode 'at greater distances from each other

than has been previously envisaged', indicating that the 500 nm spacing specified is a minimum limit to be increased upon, rather than reduced 100 fold". Please see the above response.

Applicants argue that "as shown above, the claimed range is not an optimization of the prior art range - rather, the range pertains to a completely different field of art", and that "the prior art mechanism of thermionic emission would gain no benefit from implementation of the claimed ranges". As discussed above, Cox and Tavkhelidze et al. disclose a tunnel diode which can operate as a vacuum diode heat pump, and the gap separation can be controlled to optimize electron tunneling. Also, Applicants do not provide evidence that controlling the gap separation would not improve the performance of the tunnel diode.

Applicants argue that "claims 7, 8, 17 and 18 are patentable over the prior art of Bell in view of Tavkhelidze due to the significant differences between Bell's collector electrode and the collector electrode of the current invention". Applicants do not claim a specific structure or composition of the collector beyond the limitation that the collector comprises a band gap material (and a metal).

Applicants argue that "Bell does not teach a tunnel diode". Bell discloses a tunnel diode as discussed above.

Applicants argue that "Bell's invention is a thermionic converter in which a heat source and sink provide the temperature differential required for electrons to travel between the electrodes (Figs. 1 and 8)". Bell discloses a tunnel diode as discussed

above. Further, Applicants claim a vacuum diode heat pump in claim 10 which would have a similar structure to what Bell discloses.

Applicants argue that "it would not be obvious to combine features of Bell with Tavkhelidze since the two devices belong to different fields in which the interelectrode separation has totally different significance". Both Bell and Tavkhelidze et al. disclose a tunnel diode which can operate as a vacuum diode heat pump, and the interelectrode separation can be controlled to optimize electron tunneling. Also, Applicants do not provide evidence that controlling the gap separation would not improve the performance of the tunnel diode.

## *Conclusion*

13. Applicants' amendment necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicants are reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAY C. KIM whose telephone number is (571)270-1620. The examiner can normally be reached on 7:30 AM - 5:00 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Parker can be reached on (571) 272-2298. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Matthew C. Landau/
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